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AIR TRAFFIC CONTROL

Observations on FAA's Air
Traffic Control
Modernization Program

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Mr. Chairman and Members of the Subcommittee:

We appreciate the opportunity to provide our observations on the Federal Aviation Administration's (FAA) efforts to modernize the nation's air traffic control system. In 1981, FAA began a multibillion-dollar modernization effort to improve the safety, capacity, and efficiency of this system to meet the increasing demand for air traffic services and to replace aging equipment. The agency's most recent estimate is that it will spend approximately \$41 billion on the modernization effort through 2004. FAA has had some success in deploying new modernization systems over the past two decades. However, the agency has not delivered most of its major systems within cost, schedule, and performance goals due largely to its failure to implement established guidelines for acquiring new systems. Implementing disciplined acquisition management practices is key to allowing the agency to consistently deliver new systems within established goals.

In light of past problems and continuing concerns about key projects funded under this program, you asked us to provide current information on the status of the modernization program based on prior reports and testimonies as well as ongoing work.¹ Our statement will focus on (1) the causes of the problems that have plagued FAA's modernization program for nearly two decades and (2) recent agency efforts to overcome these problems. We will also discuss our concerns about the readiness of FAA and others to meet Year 2000 requirements.

In summary:

- From the inception of the air traffic control modernization program to today, FAA has not consistently followed a disciplined management approach for acquiring new systems. In the 1980s and early 1990s, FAA did not follow the phased approach of federal acquisition guidance designed to help mitigate the cost, schedule, and performance risk associated with the development of major systems. The agency believed that it could develop and install new systems more quickly by combining several of the five phases outlined in this guidance. However, as a result of not following this disciplined, phased approach, FAA often encountered major difficulties such as those associated with developing the Advanced Automation

¹See Air Traffic Control Modernization: Status of FAA's Modernization Program (GAO/RCED-99-25, Dec. 3, 1998) for our most recent work on air traffic control modernization.

System.² In 1995, the Congress exempted FAA from many federal procurement rules and regulations. In April 1996, FAA implemented an acquisition management system, which emphasized, once again, the need for a disciplined approach to acquisition management. However, we found continuing weaknesses in key areas such as how FAA monitors the status of projects throughout their life-cycle.

- FAA has taken a number of steps to overcome problems with past modernization efforts. Most notably, the agency has moved away from its prior practice of taking on large, complex projects all at once and is now acquiring new systems by using a more incremental approach. In addition, the agency is no longer making unilateral decisions about air traffic control modernization. Instead, it has been working actively with the aviation community to make decisions more collaboratively. Furthermore, FAA has begun to address some of the root causes of its modernization problems by implementing processes to help (1) improve its ability to estimate and account for project costs, (2) develop a complete architecture (blueprint) for modernizing the National Airspace System, (3) reduce the risks associated with software development, and (4) reform the organization's culture, including providing incentives to make managers more accountable. While FAA has delivered some of its major systems, it must be recognized that many of these projects encountered difficulties in meeting their original cost and schedule goals, and the baselines were subsequently revised.
- FAA has taken critical steps over the past year to address problems associated with the date change to the year 2000, but much work remains to be done to help ensure that FAA and other key players such as airports have made needed fixes and have contingency plans in place so that operations can continue should problems arise.

Background

As the principal component of the National Airspace System, FAA's air traffic control system must operate continuously—24 hours a day, 365 days a year. Under federal law, FAA has the primary responsibility for operating a common air traffic control system—a vast network of radars; automated data processing, navigation, and communications equipment; and air traffic control facilities. FAA meets this responsibility by providing such services as controlling takeoffs and landings and managing the flow

²AAS—the centerpiece of the modernization program—was designed to replace the computer hardware and software, including workstations, used by controllers in air traffic control facilities. Numerous development problems led the agency to restructure the project in 1994.

of air traffic between airports.³ The users of FAA's services include the military, other government users, private pilots, and commercial aircraft operators.⁴ Projects in FAA's modernization program are primarily organized around seven functional areas—automation, communications, facilities, navigation and landing, surveillance, weather, and mission support.

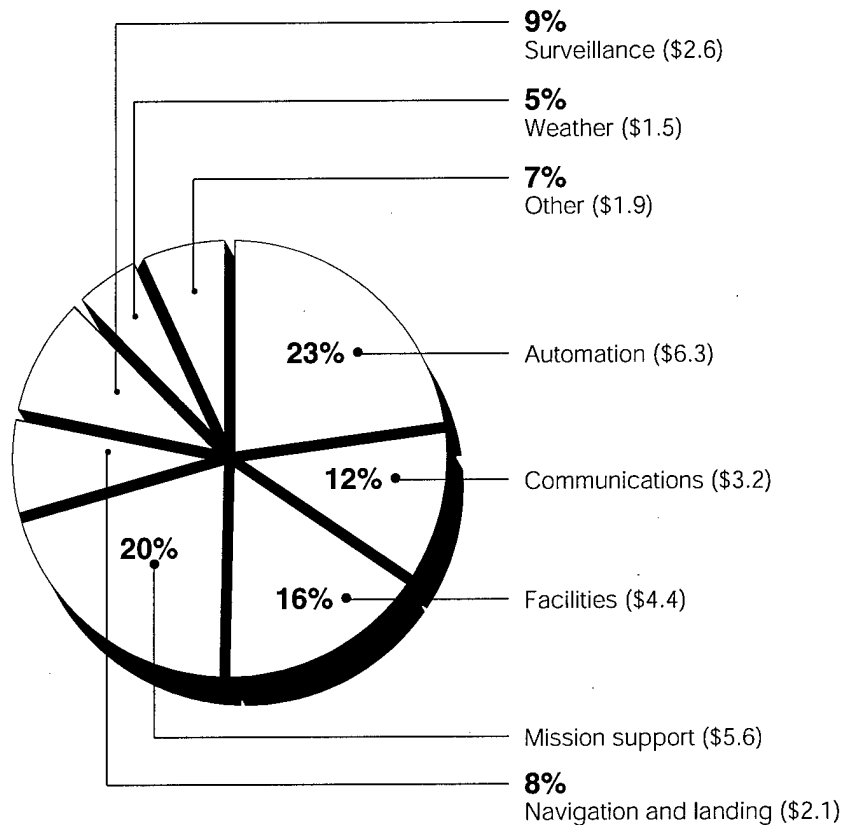
FAA expects to spend approximately \$41 billion for its modernization program through 2004.⁵ Of this amount, Congress appropriated over \$27 billion for fiscal years 1982 through 1999. The agency expects that approximately \$13 billion will be provided for fiscal years 2000 through 2004. See figure 1 for an illustration of how FAA's appropriation was divided among the seven functional areas.

³FAA uses three types of facilities to control traffic. Airport towers direct traffic on the ground, before landing, and after takeoff within about 5 nautical miles from the airport and about 3,000 feet above the airport. Terminal radar approach control (TRACON) facilities sequence and separate aircraft as they approach and leave airports, beginning about 5 nautical miles and ending about 50 nautical miles from the airport and generally up to 10,000 feet above the ground. Air route traffic control centers, called en route centers, control planes in transit and during approaches to some airports. The airspace that most en route centers control extends above 18,000 feet for commercial aircraft. En route centers also handle aircraft at lower altitudes when dealing directly with a control tower or when agreed upon with a terminal facility.

⁴The Department of Defense (DOD), with FAA's authority and oversight, also provides air traffic services, primarily in support of its military mission but also to civil users. The DOD operates tower and terminal facilities; therefore, FAA and DOD have formally agreed to cooperate in modernizing air traffic control facilities.

⁵Total spending on modernization includes all actual and projected facilities and equipment appropriations from fiscal year 1982 through fiscal 2004 for projects in FAA's financial plan. Projected appropriations for future years fluctuate so the total estimated spending will vary. FAA's financial plan contains funding primarily for projects, including prime contract costs; costs for personnel compensation, benefits, and travel; and contract costs for technical support service activities. The plan also includes estimated future costs for some projects that have not yet been funded but are part of the National Airspace System architecture.

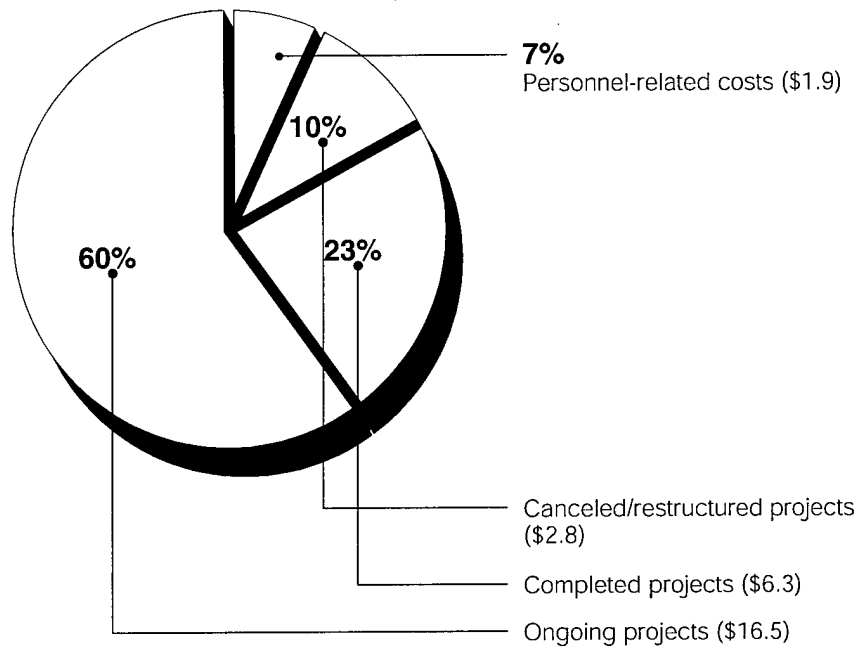
Figure 1: Air Traffic Control Modernization: Funding by Functional Areas, FY 1982-99 (Dollars in billions)



Source: FAA.

Figure 2 illustrates how FAA's appropriation was divided by project status—completed projects, ongoing projects, canceled/restructured projects, and personnel-related expenses.

**Figure 2: Air Traffic Control
Modernization: Funding by Project
Status, FY 1982-1999** (Dollars in billions)



Source: FAA.

Over the past 17 years, FAA's modernization projects have experienced substantial cost overruns, lengthy schedule delays, and significant performance shortfalls. Because of the size, complexity, cost, and problem-plagued past of FAA's modernization program, we have designated it a high-risk information technology investment since 1995.⁶

⁶FAA's modernization program is one of four high-risk system development and modernization efforts. See *High-Risk Series: An Overview* (GAO/HR-95-1, Feb. 1995), *High-Risk Series: Information Management and Technology* (GAO/HR-97-9, Feb. 1997), and *High-Risk Series: An Update* (GAO/HR-99-1, Jan. 1999).

FAA Has Historically Not Followed a Disciplined Acquisition Management Approach

FAA has encountered difficulty in acquiring new systems to help achieve its goals of replacing the air traffic control system's aging infrastructure and of meeting the projected increase in air traffic. In the 1980s and early 1990s, the agency did not follow the structured approach outlined in federal acquisition guidance. Even after the agency revised its approach in 1991—to address past shortcomings in the design and implementation of the approach—problems persisted with FAA's air traffic control modernization program. In 1996, FAA began a new approach that emphasized, once again, the need for discipline in selecting, monitoring, and evaluating modernization projects. Despite this new approach, problems persist with FAA's ability to effectively implement and manage its modernization program. We have identified a number of root causes that have contributed to modernization problems. These causes are related to the lack of a disciplined acquisition management approach.

During the First Decade of Modernization, FAA Did Not Follow a Disciplined Approach

In the 1980s and early 1990s, we reported that problems with modernization projects occurred largely because FAA did not follow the guidance outlined in Office of Management and Budget Circular A-109, which is the principal guidance for acquiring major systems in the federal government.⁷ Circular A-109 calls for following a disciplined, five-phased approach to acquisition in order to minimize problems, such as cost increases and schedule delays. The five phases include (1) determining mission needs; (2) identifying and exploring alternative design concepts; (3) demonstrating alternative design concepts, including prototype testing, and evaluation; (4) initiating full-scale development and limited production, including independent testing; and (5) full production. Before moving from one phase to the next, the guidance calls for a key decision point, at which time agency heads are to evaluate the cost, schedule, and performance parameters of major projects. During these reviews, any management concerns about these parameters must be resolved before the acquisition is allowed to proceed.

From the inception of the air traffic control modernization program until 1991, FAA did not follow Circular A-109 guidance. The agency believed that it could deliver and install new systems more quickly by combining Circular A-109 phases. For example, FAA merged the first three phases into one, under which the agency performed some prototype testing but ignored mission need and alternative analyses. However, FAA's failure to follow Circular A-109 resulted in delays in many of the major systems in

⁷On April 5, 1976, the Executive Office of the President, Office of Management and Budget, issued Circular A-109. The circular was designed to improve the effectiveness of the management of major system acquisitions.

the modernization effort, most notably FAA's centerpiece project, known as the Advanced Automation System (AAS). For example, FAA contracted for the production of a key component of this project before it had fully defined requirements for this component. Between 1983 and 1991, the lack of clarity and decisiveness in resolving requirements contributed to costs for the project increasing from \$2.6 billion to \$4.5 billion and the schedule slipping by 7 years.

FAA Incorporated Circular A-109 Guidance Into Its Approach in 1991

In February 1991, FAA issued revised guidance on major acquisitions, which put FAA policy in compliance with Circular A-109. Among the changes incorporated in this guidance was a requirement that new projects have a mission needs statement approved before being included in FAA's budget. The guidance also required that alternatives be identified and evaluated and that operational testing be conducted and reviewed by an independent test group within FAA before production decisions were made. Moreover, FAA required that program managers submit a risk management plan, including measures to reduce risk, that FAA senior managers must approve before an acquisition could proceed to the next phase. Program managers were also required to develop acquisition program baselines (boundaries) for the most costly major acquisitions—usually those exceeding \$150 million. These baseline documents were intended to promote stability and control costs by establishing quantified targets for key performance, cost, and schedule parameters that are critical to the success of the acquisition.

Although FAA revised its acquisition policies in 1991 to instill more discipline into the acquisition management process, shortcomings in both design and implementation limited the process's effectiveness. For example, the agency's acquisition orders and guidance still did not require an analysis of current system performance as the starting point in the acquisition process. Instead, under the order, the starting point for the acquisition process was the mission needs statement. The order did not include any procedures or guidance for conducting a mission analysis before generating mission needs statements and made little mention of what types of data analyses were expected. As a result, the agency did not document that its current assets could no longer fulfil its needs and did not have any assurance that it was not wasting scarce resources in developing systems that were not the most appropriate and cost-effective. Similarly, senior acquisition officials did not thoroughly review project justifications to ensure that they were adequately supported. Other conditions that contributed to this lack of discipline in FAA's acquisition

process during this period included the frequent turnover of FAA senior managers. For example, between 1982 and 1995, the average tenure of the FAA Administrator was less than 2 years. This lack of continuity in personnel allowed the agency's bureaucracy to focus on short-term improvements, avoid accountability, and resist fundamental changes.

FAA Implemented Its Acquisition Management System in 1996

FAA continued to experience problems in the mid-1990s with its major acquisitions. For example, in 1994, FAA restructured AAS after the estimated cost to deploy the system had tripled, capabilities were significantly less than promised, and delays were expected to run nearly a decade. Additionally, the costs of the Voice Switching and Control System⁸ increased by 400 percent, from about \$260 million to \$1.4 billion, and the project's planned date for implementation slipped by 6 years. Concerned about the continuing slow pace of the air traffic control modernization program—which led at times to FAA's having to implement costly interim projects to sustain the ATC system—FAA sought from the Congress exemptions from many federal procurement rules. The agency asserted that these rules contributed to its acquisition problems and that exemptions would allow it to reduce the time and cost to deliver new products and services. In response, Congress exempted FAA in 1995⁹ from many federal procurement rules, and the agency implemented its Acquisition Management System (AMS) on April 1, 1996. AMS is intended to provide high-level acquisition policy and guidance and to establish rigorous management practices for selecting and monitoring investments.

To date, FAA has established a structure that is generally sound and could provide the discipline needed to help ensure that ATC modernization projects are implemented in a cost-effective manner. However, our past and recent work have shown that FAA has fallen short when it comes to implementing practices to build discipline into acquisition management. Specifically, our preliminary findings on FAA's present approach indicate that the agency has not fully implemented an effective process for monitoring the cost, schedule, benefits, performance, and risk of its key projects throughout their life-cycle. Additionally, FAA lacks an evaluation process for assessing outcomes after projects have been developed to help improve the selection and monitoring of future projects.

⁸The Voice Switching and Control System replaces and improves ground-to-ground and air-to-ground communications equipment at FAA's air route traffic control centers.

⁹Department of Transportation and Related Agencies Appropriations Act of 1996 (P.L. 104-50).

Root Causes of Modernization Problems Are Varied

As we reported in 1995, exempting FAA from procurement rules could result in a somewhat more expeditious acquisition process, but those looking for dramatic, immediate changes in the modernization program would likely be disappointed.¹⁰ Our work showed then, and continues to show today, that the schedule, cost, and performance problems are caused by factors other than procurement rules. We have reported on several root causes of FAA's past modernization problems. First, FAA lacks reliable cost estimating practices and cost accounting data, which leaves it at risk of making ill-informed decisions on critical and costly air traffic control systems and limits the ability of congressional decisionmakers to make trade-offs among FAA programs.¹¹ Second, FAA attempted to modernize the National Airspace System without a complete systems architecture, or blueprint, to guide development and evolution and did not have the management structure needed to enforce its architecture once completed.¹² The result has been unnecessarily higher spending to buy, integrate, and maintain hardware and software. Third, FAA processes for acquiring software for air traffic control systems are ad hoc, sometimes chaotic, and not repeatable across projects.¹³ As a result, FAA is at great risk of acquiring software that does not perform as intended and is not delivered on time and within budget. Finally, FAA's organizational culture—the values, beliefs, attitudes, and expectations shared by an organization's members that affect their behavior and the behavior of the whole organization—is an underlying cause of acquisition problems.¹⁴ When employees act in ways that do not reflect a strong commitment to mission focus, accountability, coordination, and adaptability, acquisitions can be impaired. We made recommendations in these reports to correct these root causes.

¹⁰See Federal Aviation Administration: Issues Related to FAA Reform (GAO-T-RCED-95-247, Aug. 2, 1995).

¹¹See Air Traffic Control: Improved Cost Information Needed to Make Billion-Dollar Modernization Investment Decisions (GAO/AIMD-97-20, Jan. 22, 1997).

¹²See Air Traffic Control: Complete and Enforced Architecture Needed for FAA Systems Modernization (GAO/AIMD-97-30, Feb. 3, 1997).

¹³See Air Traffic Control: Immature Software Acquisition Processes Increase FAA Systems Acquisition Risks (GAO/AIMD-97-47, Mar. 21, 1997).

¹⁴See Aviation Acquisition: A Comprehensive Strategy Is Needed for Cultural Change at FAA, GAO/RCED-96-159.

FAA Has Taken Steps to Overcome Modernization Problems and Has Delivered Some Systems

FAA has taken a number of steps, in addition to implementing its Acquisition Management System, to overcome past problems with modernization efforts. However, most of these initiatives are just getting under way, and it is too soon to tell how successful they will be. Additionally, the agency has now completed work on about 90 modernization projects. In some cases, the costs were higher and the development longer than expected.

Recent Initiatives to Address Modernization Problems

The FAA Administrator took a notable step in November 1997 when she began an outreach effort to the aviation community to build consensus on and seek commitment to the future direction of the agency's modernization program. As a result of this outreach effort, FAA and the aviation community agreed to (1) use an incremental approach to modernizing the National Airspace System, referred to as the "build a little, test a little" approach; (2) revise its blueprint for modernizing this system; and (3) deploy certain technologies earlier than FAA had planned because the aviation industry believed that these technologies could provide immediate benefits. These practices differ from those of the past in which FAA made unilateral decisions about air traffic control modernization and tried to deploy large, complex projects all at once, known as the "big bang" approach.

Furthermore, FAA has actions under way to address the root causes we have identified in the past with its acquisitions. First, FAA has begun to develop a cost estimating process for its projects that will satisfy recognized estimating standards; draft guidance on reporting project cost estimates as ranges rather than precise point estimates; and develop a cost accounting system. Specifically, FAA plans to complete a cost estimating handbook, which should help improve the agency's approach to estimating project costs. However, FAA has not established a firm date for issuing the handbook or for completing other tasks related to cost estimating. As for cost accounting, FAA had hoped to have a system operating by October 1998, but officials underestimated the complexity of developing the system and found that their implementation milestones were unrealistic. The agency now projects that the system will be fully operational by April 2001. Second, FAA has begun to develop a complete systems architecture for its modernization program and estimated in May 1998 that it would take 18 to 24 months to complete the development. Third, FAA has initiated efforts to improve its software acquisition processes. However, these efforts have not been implemented agencywide. In this connection, the

agency hired a Chief Information Officer in February 1999. It is expected that FAA will establish a management structure similar to the department-level Chief Information Officers provision of the Clinger-Cohen Act of 1996, as we recommended.¹⁴ If so, the Chief Information Officer organization would be responsible for activities related to information technology, including software acquisition and systems architecture. Finally, FAA has outlined its overall structure for changing its organizational culture and described its ongoing actions to influence organizational culture.¹⁵ In this area, FAA has a pilot program under way for a new compensation program that it plans to implement agencywide.

FAA Has Delivered Some Modernization Systems

In recent years, FAA has claimed some success with delivering systems under its modernization program. While the agency has completed some modernization projects since 1982, many of the major projects, especially in the automation area, are years behind schedule. The agency has spent \$6.3 billion of the over \$27 billion appropriated between 1982 and 1999 on 93 completed projects. We note that although FAA completed several of its major projects, they generally cost more than anticipated and were delivered behind schedule. For example, FAA has declared the Display System Replacement a success because it deployed operational equipment to the first of 20 sites in December 1998.¹⁶ However, FAA's 1983 modernization plan called for a similar system under the Advanced Automation System to be deployed in 1990. Likewise, FAA is now completing the deployment of other key systems first identified in its 1983 modernization plan. For example, FAA expects to complete the deployment later this year of two projects—Airport Surface Detection Equipment and Air Route Surveillance Radar—which were originally scheduled to be completed in 1990 and 1995, respectively.¹⁷ Of FAA's key modernization projects, the agency has successfully deployed two large-scale projects over the past 17 years—both involving the HOST computer system.¹⁸ FAA completed the implementation of the HOST computer in 1988 and is

¹⁴The Clinger-Cohen Act requires that major federal departments and agencies establish Chief Information Officers that report to the department/agency head and are responsible for developing, maintaining, and facilitating the acquisition of information technology systems.

¹⁵See *Strategy for Acquisition Culture Change*, FAA (June 1997).

¹⁶The Display System Replacement will modernize en route center equipment by replacing 20-to-30-year-old display channels, controllers' workstations, and network infrastructure.

¹⁷Airport Surface Detection Equipment detects traffic on airport runways. Air Route Surveillance Radar detects air traffic and weather in the en route environment.

¹⁸The HOST computer is the centerpiece information-processing system in FAA's en route centers. It processes flight, radar, and display data for use by the controllers.

currently replacing portions of this system. Both of these projects involve replacing hardware while utilizing existing system software.

Progress Made on Addressing Year 2000 Problems

On a related issue, our work on the Year 2000 problem has shown that FAA has made tremendous progress over the past year, but much remains to be done to complete the validation and implementation of FAA's mission-critical systems.¹⁹ In addition to these systems, the agency is concerned that system failures by external organizations, such as airports and foreign air traffic control systems could seriously affect FAA's ability to provide aviation services. For example, we recently reported that 26 of the largest 50 airports in the United States are not planning to be Year 2000 compliant by June 30, 1999.²⁰ Because of the risk of anticipated and unanticipated failures—whether from internal systems or from reliance on external partners and suppliers—a comprehensive business continuity and contingency plan is crucial to continuing core operations. FAA drafted its Year 2000 Business Continuity and Contingency Plan in December 1998 and is currently reviewing it. The agency plans to release four more iterations of this plan by the end of the year, with the next version due out in April 1999. We and others have expressed some concerns with FAA's draft plans, which the agency is working to address.

In conclusion Mr. Chairman, FAA has fallen short over the past two decades in implementing a disciplined management acquisition approach. While the agency has many of the elements in place to improve its management of the modernization program, implementation is key to the agency's future success in this area. Among the positive steps that FAA has taken include actions to bring stability to the agency's senior management ranks, as evidenced by the Administrator's commitment to serve a full 5-year term. Moreover, she has filled many key management positions that had been vacant and has also begun to provide senior managers with incentives to work together toward agency goals. For the most part, FAA will need to sustain its commitment to fully implementing the various initiatives underway. As a first priority, it will be important for the agency to continue all of its efforts to help ensure that it can fulfill its mission when the year 2000 arrives. As for the longer-term, FAA's continued collaboration with the aviation community will allow the agency to

¹⁹See Year 2000 Computing Crisis: FAA is Making Progress But Important Challenges Remain (GAO/T-AIMD/RCED-99-118, Mar. 15, 1999).

²⁰See Year 2000 Computing Crisis: Status of Airports' Efforts to Deal with Date Change Problem (GAO/RCED/AIMD-99-57, Jan. 29, 1999).

develop future plans for air traffic control modernization, including establishing realistic and clear goals and measures for tracking progress. Similarly, fully implementing solutions to the root causes of modernization problems and strengthening FAA's control over modernization investments will better position the agency to consistently deliver modernization projects within established cost, schedule, and performance goals.